showing the movement in the line of sight of the F line caused by the presence of a protuberance in the region of the spot. "The Length of our Earth-days," "A Lost Comet," and "Paris Scientific Undertakings" are titles of other communications, the last of which is a brief general survey of recent additions to our knowledge about the construction and movement of the visible universe.

ASTRONOMY AT THE COLUMBIAN EXPOSITION.—Arrangements are about to be made for organizing a series of congresses or conventions to be held next year during the progress of the World's Exposition. The preliminary address of the General Committee on Mathematics and Astronomy points out that such a congress should take advantage of the presence of the leading scholars of the world for the mutual interchange of ideas by presenting and considering investigations in special lines of research.

The sections dealing with Astronomy and Astro-Physics are eight in number and are as follows :—

Astronomy.

a. History of Astronomy.
b. Astronomical Instruments.
c. Methods of Observation.
d. Physical Astronomy.
e. Observatory Buildings.

Astro-Physics.

a. Spectrum Analysis.
b. Astronomical Photography.
c. Stellar Photometry.

The address further states that advice and suggestions with regard to the general conduct of the convention are earnestly invited, while special stress is laid on the scientific questions for future discussion. The Chairmen of the Special Committees of the several subjects under the charge of the General Committee are as follows :—

Pure Mathematics.—Prof. E. H. Moore, Chicago University.

Astronomy.—Prof. G. W. Hough, Dearborn Observatory, North-western University, Evanston.

Astro-Physics.—Prof. George E. Hale, Kenwood Astro-Physical Observatory, Chicago.

Among the names in the partial lists of the Advisory Councils on these two subjects we notice those of Prof. A. Cayley and Prof. J. J. Sylvester for mathematics, and S. Copeland (Astronomer Royal for Scotland), Prof. R. S. Ball, Prof. Gill, Mr. Norman Lockyer, the Earl of Rosse, Prof. Liveing, Prof. Dewar, and Dr. Huggins.

LUNAR ECLIPSE, MAY 11, 1892.—With reference to the lunar eclipse that occurred last May, *Astronomische Nachrichten* No. 3106 contains a series of accounts, which include the times of immersion and emersion of the objects on the moon's surface, gathered from the following observatories :—Bonn, Heidelberg, Breslau, Christiania, Prag, Kiel, and Kalocsa.

NUMERATION OF ASTEROIDS.—The *Astronomical Journal* No. 271 contains the announcement that an arrangement had been agreed upon by which the numeration of asteroids will in future be put on a sound basis. For the present Prof. Krueger will assign to these bodies the notation 1892 A, B, C...in the order in which their announcement is sent to the Telegraphische Central-Stelle, Prof. Tietzen, Director of the Rechen Institute in Berlin, in the meantime undertaking their definite numeration. This arrangement will be found to avoid all such confusion as has been experienced with regard to those asteroids about which sufficient information is not available for their orbital determinations. Although they will not now receive their numbers, they can easily be recognized by their lettering in the annual series.

THE BRITISH ASSOCIATION.

SECTION C.

GEOLOGY.

OPENING ADDRESS BY PROF. C. LAPWORTH, LL.D., F.R.S., F.G.S., PRESIDENT OF THE SECTION.

IT has, I believe, been the rule for the man who has been honoured by election to the chair of President of the Geological Section of the British Association to address its members upon the recent advances made in that branch of geology in which he has himself been most immediately interested. It is not my intention upon the present occasion to depart from this time-honoured custom; for it has both the merit of simplicity and the advantage of utility to recommend it. In this way each branch of our science, as it becomes in turn represented, not only submits to the workers in other departments a report of its own progress, but presents by implication a broad sketch of the entire geological landscape, seen through the coloured glasses, it may be, of divisional prejudice, but at any rate instructive and corrective to the workers in other departments, as being taken from what is to them a novel and an unfamiliar point of view.

Now every tyro in geology is well aware of the fact that the very backbone of geological science is constituted by what is known as stratigraphical geology, or the study of the geological formations. These formations, stratified and unstratified, build up all that part of the visible earth-crust which is accessible to the investigator. Their outcropping edges constitute the visible exterior of our globe, the surface of which forms the physical geography of the present day, and their internal characters and inter-relationships afford us our only clues to the physical geographies of bygone ages. Within them lies enshrined all that we may ever hope to discover of the history and the development of the habitable world of the past.

These formations are to the stratigraphical geologist what species are to the biologist, or what the heavenly bodies are to the astronomer. It was the discovery of these formations which first elevated geology to the rank of a science. In the working out of their characters, their relationships, their development, and their origin, geology finds its means, its aims, and its justification. Whatever fresh material our science may yield to man's full conception of nature, organic and inorganic, must of necessity be grouped around these special and peculiar objects of its contemplation.

When the great Werner first taught that our earth-crust was made up of superimposed rock-sheets or formations arranged in determinable order, the value of his conclusions from an economic point of view soon led to their enthusiastic and careful study; and his crude theory of their successive precipitation from a universal chaotic ocean disarmed the suspicions of the many until the facts themselves had gained such a wide acceptance that denial was no longer possible. But when the greater Hutton asserted that each of these rock formations was in reality nothing more nor less than the recemented ruins of an earlier world, the prejudices of mankind at large were loosed at a single stroke. Like Galileo's assertion of the movement of the globe, this demanded such an apparently undignified and improbable mode of creation that there is no wonder that, even down to the present day, there still exist some to whom this is a hard saying, to be taken, if taken at all, in homœopathic doses and with undisguised reluctance.

Hutton, as regards his philosophy, was, as we know, far in advance of his time. With all the boldness of conviction he unflinchingly followed out these ideas to their legitimate results. He claimed that as the stratified formations were composed of similar materials—sands, clays, limestones, and muds—to those now being laid down in the seas around our present coasts, they must, like them, have been the products of ordinary natural agencies—of rain, rivers, and sea waters, internal heat and external cold—acting precisely as they act now. And further as these formations lie one below the other, in apparently endless downward succession, and all are formed more or less of these fragmentary materials, so the present order of natural phenomena must have existed for untold ages. Indeed, to the commencement of this order he frankly admits, "I see no trace of a beginning or sign of an end."

The history of the slow acceptance of Hutton's doctrines, even among geologists, is, of course, perfectly familiar to us all. William Smith reduced the disputed formations to order, and showed that not only was each composed of the ruins of a vanished land, but that each contained in its fossils the proof that it was deposited in a vanished sea inhabited by special life creation. Cuvier followed, and placed it beyond question that the fossilized relics of these departed beings were such as made it absolutely unquestionable that these creatures might well have inhabited the earth at the present day. Lyell completed the cycle by demonstrating stage by stage the efficiency of present natural agencies to do all the work required for the degradation and rebuilding of the formations. Since his day the students of stratigraphical geology have universally acknowledged that in the study of present geographical causes lies the key to the geological formations and the inorganic world of the past.

In this way the road was paved for Darwin and the doctrine of descent. The aid which had been so ungrudgingly afforded by biology to geology was repaid by one of the noblest presents ever made by one science to another. For the purposes of geology, the science of biology had practically completed a double demonstration: first, that the extinct life discernible in the geological formations was linked inseparably with the organic life of the present; and, second, that every fossil recognized by the geologist was the relic of a creature that might well have existed upon the surface of the earth at the present time. Geology repaid its obligation to biology by the still greater twofold demonstration: first, that in the economy of nature the most insignificant causes are competent to the grandest effects, if only a sufficiency of time be granted them; and, second, that in the geological formations we have the evidences of the actual existence of those mighty eons in which such work might be done.

The doctrine of organic evolution would always have remained a metaphysical dream had geology not given the time in which the evolution could be accomplished. The ability of present causes to bring about slow and cumulative changes in the species is, to all intents and purposes, a biological application of Hutton's ideas with respect to the original geological formations. Darwin was a biological evolutionist, because he was first an uniformitarian geologist. Biology is pre-eminent to-day among the natural sciences, because its younger sister, Geology, gave it the means.

But the inevitable consequence of the work of Darwin and his colleagues was that the centre of gravity, so to speak, of popular regard and public controversy was suddenly shifted from stratigraphical geology to biology. Since that day stratigraphical geology, to its great comfort and advantage, has gone quietly on its way unchallenged, and all its more recent results have, at least by the majority of the wonder-loving public, been practically ignored.

Indeed, to the outside observer it would seem as if stratigraphical geology for the last thirty years had been practically at a standstill. The startling discoveries and speculations of the brilliant stratigraphists of the end of the last century and first half of the present forced the geology of their day into the very front rank of the natural sciences, and made it perhaps the most conspicuous of them all in the eyes of the world at large. Since that time, however, their successors have been mainly occupied in completing the work of the great pioneers. The stratigraphical geologists themselves have been almost wholly occupied in laying down upon our maps the superficial outlines of the great formations, and working out their inter-relationships and subdivisions. At the present day the young stratigraphical student soon learns that all the limits of our great formations have been laid down with accuracy and clearness, and finds but little to add to the accepted nomenclature of the time.

Our palæontologists also have equally busied themselves in working out the rich store of the organic remains of the geological formations, and the youthful investigator soon discovers that almost every fossil he is able to detect in the field has already been named, figured, and described, and its place in the geological record more or less accurately fixed.

In France, in Germany, in Norway, Sweden, and elsewhere, in Canada and in the United States, work as thorough and as satisfactory has been accomplished, and the local development of the great stratified formations and their fossils laid down with detail and clearness.

Many an unfledged, but aspiring geologist, alive to these facts, and contrasting the well-mapped ground of the present time with the virgin lands of the days of the great pioneers, finds it hard to stifle a feeling of keen regret that there are nowadays no new geological worlds to conquer, no new systems to discover and name, and no strange and unexpected faunas to unearth and bring forth to the astonished light of day. The youth of stratigraphical geology, with all its wonder and freshness, seems to have departed, and all that remains is to accept, to commemorate, and to round off the glorious victories of the dead heroes of our science.

But to the patient stratigraphical veteran, who has kept his eyes open to discoveries new and old, this lull in the war of geological controversy presents itself rather as a grateful breathing time; the more grateful as he sees looming rapidly up in front the vague outlines of those oncoming problems which it will be the duty and the joy of the rising race of young geologists to grapple with and to conquer, as their fathers met and vanquished the problems of the past. He knows perfectly well that Geology is yet in her merest youth, and that to justify even her very existence there can be no rest until the whole earth-crust and all its phenomena, past, present, and to come, have been subjected to the domain of human thought and comprehension. There can be no more finality in Geology than in any other science; the discovery of to-day is merely the stepping-stone to the discovery of to-morrow; the living theory of to-morrow is nourished by the relics of its parent theory of to-day.

Now if we ask what are these formations which constitute the objects of study of the stratigraphical geologist, I am afraid that, as in the case of the species of the biologist, no two authorities would agree in framing precisely the same definition. The original use of the term *formation* was of necessity lithological, and even now the name is most naturally applied to any great sheet of rock which forms a component member of the earth-crust; whether the term be used specifically for a thin homogeneous sheet of rock like the Stonesfield slate, ranging over a few square miles; or generically, for a compound sheet of rock, like the Old Red Sandstone, many thousands of feet in thickness, but whose collective lithological characteristics give it an individuality recognizable over the breadth of an entire continent.

When Werner originally discovered that the "formations" of Saxony followed each other in a certain recognizable order, a second characteristic of a formation became superposed upon the original lithological conception—namely, that of determinate "relative position." And when William Smith proved that each of the formations of the English Midlands was distinguished by an assemblage of organic remains peculiar to itself, there became added yet a third criterion—that of the possession of "characteristic fossils."

But these later superposed conceptions of time-succession and life-type are far better expressed by dividing the geological formations into zoological *zones*, on the one hand, and grouping them together, on the other hand, into chronological *systems*. For in the experience of every geologist he finds his mind instinctively harking back to the bare lithological application of the word "formation," and I do not see that any real advantage is gained by departing from the primitive use of the term.

A *zone*, which may be regarded as the *unit* of *palæontological succession*, is marked by the presence of a special fossil, and may include one or many subordinate formations. A *system*, which is, broadly speaking, the *unit of geological succession*, includes many "zones," and often, but not always, many "formations." A *formation*, which is the *unit of geological stratigraphy*, is a rock sheet composed of many strata possessing common lithological characters. The formation may be simple, like the Chalk, or compound, like the New Red Sandstone; but, simple or compound, local or regional, it must be always recognizable, geographically and geologically, as a lithological individual.

As regards the natural grouping of these lithological individuals as such, fair progress has been made of late years, and our information is growing apace. We know that there are at any rate three main groups: 1st. The stratified formations due to the action of moving water above the earth-crust; 2nd. The igneous formations which are derived from below the earth-crust; 3rd. The metamorphic formations which have undergone change within the earth-crust itself. We know also that of these three the only group which has hitherto proved itself available for the purpose of reading the past history of the globe is that of the stratified formations.

Studying these stratified formations therefore in greater detail, we find that they fall naturally in their turn into two sets—viz., a mechanical set of pebble beds, sandstones and clays formed of rock fragments washed off the land into the waters, and an organic set of limestones, chalk, &c., formed of the shells and exuviæ of marine organisms.

But when we attempt a further division of these two sets our classification soon begins to lose its definiteness. We infer that some formations, such as the Old Red and the Triassic, were the comparatively rapid deposits of lakes and inland seas; that others, like the Coal Measures, London Clay, &c., were the less rapid deposits of lagoons, river valleys, deltas, and the like; that others, like our finely laminated shales and clays of the Silurian and Jurassic, were the slower deposits of the broader seas; and finally, that others, like our Chalk and Greensand, were possibly the extremely slow deposits of the more oceanic deeps.

Nevertheless, after looking at the formations collectively, there remains no doubt whatever in the mind of the geologist that their mechanical members are the results of the aqueous degradation of vanished lands, and that their organic members are the accumulated relics of the stony secretions of what once were living beings. Neither is there any possibility of escape from the conclusion that they have all been deposited by water in the superficial hollows of the sea-bottoms and ocean floors of the earth-crust of their time.

In the life of every individual stratified formation of the mechanical type we can always distinguish three stages: first, the stage of erosion and transportation, in which the rock fragments were worn off the rocks of the higher ground and washed down by rain and rivers to the sea; second, a stage of deposition and consolidation below the surface of the quiet waters; and third, a final stage in which the completed rock-formation was bent and upheaved, in part at least, into solid land. In the formations of the organic type three corresponding stages are equally discernible: first, the period of mineral secretion by organized beings; second, the period of deposition and consolidation; and third, the final period of local elevation in mass. But one and all, mechanical and organic alike, they bear in their composition, in their arrangement, and in their fossils, abundant and irresistible evidences that they *were* the products, and that now they *are* the memorials of the physical geography of their time.

Guided by the principles of Hutton and Lyell, geologists have worked out with great care and completeness the effects of those agencies which rule in the first of these three life-stages in the history of a mechanical formation. No present geological processes are better known to the young geologist than those of denudation, erosion, and transportation, so familiar to us in the eloquent works of our President. They form together the subject-matter of that most wonderful fascinating chapter in geology, which from its modest opening among the quiet Norfolk sandhills sweeps upwards and onwards without a break to its magnificent close on the brink of the gorge of the Colorado. But our knowledge of the detailed processes of deposition and consolidation which rule in the second stage is still exceedingly imperfect, although a flood of light has been thrown upon the subject by the brilliant results of the *Challenger* expedition. And we are compelled to admit that our knowledge of the operations of those agencies which rule in the processes of upheaval and depression is as yet almost nil; and what little we have already learnt of the effects of those agencies is the prey of hosts of conflicting theories that merely serve to annoy and bewilder the working student of the science.

But not one of the formative triad of detrition, deposition, and elevation can exist without the others. No detrition is possible without the previous upheaval of the rock-sheet, from which material can be removed; no deposition is possible without the previous depression of the rock-sheet, which forms the basin in which the fragmentary material can be laid down.

Our knowledge, therefore, of the origin and meaning of any geological formation whatever, can at most be only fragmentary until this third chapter in the life-history of the geological formation has been attacked in earnest.

Now all the rich store of knowledge that we possess respecting the first stage in the life of a geological formation has been derived from a comparison of certain phenomena which the stratigraphical geologist finds in the rock formations of the past, with correspondent phenomena which the physical geographer discovers on the surface of the earth of the present. And all that we know of the second stage again has been obtained in precisely the same way. Surely analogy and common sense both teach us that all which is likely to be of permanent value to us as regards the final stage of elevation and depression must first be sought for in the same direction.

Within the last twenty years or so many interesting and vital discoveries have been made in the stratigraphy of the rock formations, which bear largely upon this obscure chapter of elevation and depression. And I propose on this occasion that we try to summarize a few of these new facts, and then, reading them in conjunction with what we actually know of the physical geography of the present day, try to ascertain how such mutual agreement as we can discover may serve to aid the stratigraphical geologist in his interpretation of the true meaning of the geological formations themselves. We may not hope for many years to come to read the whole of this geological chapter, but we may perhaps modestly essay an interpretation of one or two of the opening paragraphs.

In the physical geography of the present day we find the exterior of our terraqueous globe divided between the two elements land and water. We know that the solid geological formations exist everywhere beneath the visible surface of the lands, but of their existence under the present ocean floor we have as yet no absolute certainty. We know both the form of the surface and the composition of the outer layers of the continental parts of the lithosphere; we only know as yet even in outline the form of the surface of its oceanic portions. The surface of each of our great continental masses of land resembles that of a long and broad arch-like form, of which we see the simplest type in the New World. The surface of the North American arch is sagged downwards in the middle into a central depression which lies between two long marginal plateaux, and these plateaux are finally crowned by the wrinkled crests which form its modern mountain systems. The surface of each of our ocean floors exactly resembles that of a continent turned upside down. Taking the Atlantic as our simplest type, we may say that the surface of an ocean basin resembles that of a mighty trough or syncline, buckled up more or less centrally into a medial ridge, which is bounded by two long and deep marginal hollows, in the cores of which still deeper grooves sink to the profoundest depths. This complementary relationship descends even to the minor features of the two. Where the great continental sag sinks below the ocean level, we have our gulfs and our Mediterraneans, seen in our type continent as the Mexican Gulf and Hudson Bay. Where the central oceanic buckle attains the water-line, we have our oceanic islands, seen in our type ocean as St. Helena and the Azores. Although these apparent crust-waves are neither equal in size nor symmetrical in form, this complementary relationship between them is always discernible. The broad Pacific depression seems to answer to the broad elevation of the Old World—the narrow trough of the Atlantic to the narrow continent of America.

Every primary wave of the earth's surface is broken up into minor waves, in each of which the ridge and its complementary trough are always recognizable. The compound ridge of the Alps answers to the compound Mediterranean trough; the continous western mountain chain of the Americas to the continuous hollow of the Eastern Pacific which bounds them; the sweep of the crest of the Himalaya to the curve of the Indo-Gangetic depression. Even where the surface waves of the lithosphere lie more or less buried beneath the waters of the ocean and the seas, the same rule always obtains. The island chains of the Antilles answer to the several Caribbean abysses, those of the Ægean Archipelago answer to the Levantine deeps.

Draw a section of the surface of the lithosphere along a great circle in any direction, the rule remains always the same: crest and trough, height and hollow, succeed each other in endless sequence, of every gradation of size, of every degree of complexity. Sometimes the ridges are continental, like those of the Americas; sometimes orographic, like those of the Himalaya; sometimes they are local, like those of the English Weald. But so long as we do not descend to minor details we find that every line drawn across the earth's surface at the present day rises and falls like the imaginary line drawn across the surface of the waves of the ocean. No rise of that line occurs without its complementary depression; the two always go together, and must of necessity be considered together. Each pair constitutes one of those *geographical units of form* of which every continuous direct line carried over the surface of the lithosphere of our globe is made up. This unit is always made up of an arch-like rise and a trough-like depression, which shade into each other along a middle line of contrary curvature. It resembles the letter S or Hogarth's line of beauty, and is clearly similar in form to the typical wave of the physicist. Here, then, we reach a very simple and natural conclusion, viz. the surface of the earth-crust of the present day resembles that of a series of crust-waves of different lengths and different amplitudes, more or less irregular and complex, it is true, but everywhere alternately rising and falling in symmetrical halves like the waves of the sea.

Now this rolling wave-like earth-surface is formed of the outcropping edges of the rock formations which are the special objects of study of the stratigraphical geologist. If, therefore, the physiognomy of the face of our globe is any real index of the character of the personality of the earth-crust beneath it, these collective geographical features should be precisely those which answer to the collective structural characters of the geological formations.

In the earlier days of geology one of the first points recognized by our stratigraphists was the fact that the formations were successive lithological sheets, whose truncated outcropping edges formed the present surface of the land, and that these sheets lay inclined at an angle one over the other, or as William Smith quaintly expressed it, like a tilted "pile of slices of bread and butter." But as discovery progressed the explanation of this arrangement soon became evident. The formations revealed themselves as a series of what had originally been deposited as horizontal sheets, lying in regular order one over the other, but which had been subsequently bent up into alternating arches and troughs (*i.e.* the anticlines and synclines of the geologist). Their visible parts, which now constitute the surface of our habitable lands, were simply those parts of the formations which are cut by the irregular plane of the present earth's surface. All those parts of the great arches and troughs formerly occurring above that plane have been removed by denudation; all those parts below that plane lie buried still, out of sight within the solid earth-crust.

Although in every geological section of sufficient extent it was seen that the anticline or arch never occurred without the syncline or trough—in other words, that there was never a rise without a corresponding fall of the stratum, yet it is only of late years that the stratigraphical geologist has come clearly to recognise the fact that the anticline and syncline must be considered together, and must be united as a single crust-wave. For the arch is never present without its complementary trough, and the two together constitute the *tectonic*, *structural*, or *orographic unit*, namely, *The Fold*, the study of which, so brilliantly inaugurated by Heim in his "Mechanismus der Gebirgsbildung," is destined, I believe, in time, to give us the clue to the laws which rule in the local elevation and depression of the earth-crust, and furnish us with the means of discovery of the occult causes which lie at the source of those superficial irregularities which give to the face of our globe its variety, its beauty, and its habitability.

We have said already that this wave or fold of the geologist resembles that of the wave of the physicist. Now we may regard such a wave as formed of two parts, the arch-like part above and the trough-like part below. The length of the wave is naturally the length of the axial line joining the outer extremities of the arch and trough, and passing through the centre, node, or point of origin of the wave itself, which bisects the line of contrary curvature. The amplitude of the wave is the height of the arch added to the depth of the trough. The arch part of such a wave, if perfectly symmetrical, may clearly be regarded as belonging either to a wave travelling to the right, in which case the complementary trough is the one in that direction, or it may be regarded as belonging to a wave travelling to the left, in which case its trough must be the one in that direction. But as in the case of the shore wave, the advancing slope of the wave is always the steeper, and the real centre of the wave must lie half-way down this steeper slope; so there is no difficulty in recognizing the centre of a geological fold and fixing the real direction of movement.

The fold of the geologist differs from the ordinary wave of the physicist, essentially in the fact that even in its most elementary conception, as that of a plate bent by a pressure applied from opposite sides, it necessarily includes the element of thickness. And this being the case, the rock sheet which is being folded and curved has different layers of its thickness affected differently. In the arch of the fold the upper layers of the rock sheet are extended, while its lower layers are compressed. On the contrary in the trough of the fold the upper layers are compressed and the lower layers are extended. But in arch and trough alike there exists a central layer, which, beyond taking up the common wave-like form, remains practically unaffected.

But the geological fold has in addition to length and thickness, the further element of breadth, and this fact greatly complicates the phenomena.

Many of the movements which take place in a rock sheet which is being folded, or in other words those produced by the bending of a compound sheet composed of many leaves, can be fairly well studied in a very simple experiment. Take an ordinary large note-book, say an inch in thickness, with flexible covers. Rule carefully a series of parallel lines across the edges of the leaves at the top of the book, about $\frac{1}{8}$ of an inch apart, and exactly at right angles to the plane of the cover. Then, holding the front edges loosely, press the book slowly from back and front into an S-like form until it can be pressed no further. As the wave grows, it will be noticed that the cross lines which have been drawn on the upper edge of the book remain fairly parallel throughout the whole of the folding process, except in the central third of the book, where they arrange themselves into a beautiful sheaf-like form, showing how much the leaves of the book have sheared or slidden over each other in this central portion. It will also be seen when the S is complete that the book has been forced into a third of its former breadth. It is clear that the wave which the book now forms must be regarded as made up of three sections: viz. a section forming the outside of the trough on the one side, and a section forming the outside of the arch on the other, and a central or common section, which may be regarded either as uniting or dividing the other two.

As this experiment gives us a fair representation of what takes place in a geological fold, we see at a glance that the geologist is forced to divide his fold into three parts—an arch limb, a trough limb, and a middle limb—which last we may call the *copula* or the *septum*, according as we regard it as connecting or dividing the other two. Our note-book experiment shows us also that in the trough limb and the arch limb the leaves or layers undergo scarcely any change of relative position beyond taking on the growing curvature of the wave. But the layers in the central part, or *septum*, undergo sliding and shearing. It will be found also, by gripping the unbound parts of the book firmly and practising the folding in different ways, that this *septum* is also a region of warping and twisting. This simple experiment should be practised again and again until all these points are apparent, and the various stages of the folding process become clear; the surface of the book being forced first into a gentle arch-like rise with a corresponding trough-like fall; then stage by stage the arch should be pushed over on to the trough until the surfaces of the two are in contact and the book can be folded no further.

In the structure of our modern mountain ranges we discover the most beautiful illustrations of the bending and folding of the rocky formations of the earth-crust. The early results of Rogers among the Alleghanies, of Lory and Favre in the Western Alps, have been greatly extended of late years by the discoveries of Heim and Baltzer in the Central Alps, of Bertrand in Provence, of Margerie in Languedoc, of Dutton and his colleagues in the western ranges of America, and of Peach and Horne and others in the older rocks of Britain. The light these researches throw upon the phenomena of mountain structure will be found admirably summarized and discussed in the works of Leconte, of Dana, of Daubrée, of Reade, of Heim, and finally in the magnificent work of Suess, the "Antlitz der Erde," of which only the first two volumes have yet appeared.

Looking first at the mountain fold in its simplest form as that of a bent rock-plate, composed of many layers which have been forced into two similar arc-like forms, the convexities of which are turned, the one upwards and the other downwards, we find in the present mountain ranges of the globe every kind represented. We commence with one in which the arch is represented merely by a gentle swell of the rock sheet, and the trough by an answering shallow depression, the two shading into each other in an area of contrary flexure. From this type we pass insensibly to others in which we see that the sides of the common limb or septum are practically perpendicular. From these we pass to folds in which the twisted common limb or septum overhangs the vertical, and so on to that final extreme, where the arch limb has been pushed completely over on to the trough limb, and all three members, as in our note-book experiment, are practically welded into one conformable solid mass.

Although the movements of these mountain folds are slow and insensible, and only effected in the course of ages, so that little or no evidence of the actual movement of any single one of them has been detected since they were first studied, yet it is perfectly plain that when we regard them collectively, we have here crust folds in every stage of their existence. Each example in itself represents some one single stage in the lifetime of a single fold. They are simply crust folds of different ages. Some are, as it were, just born; others are in their earliest youth. Some have attained their majority, some are in the prime of life, and some are in the decrepit stages of old age. Finally, those in which all three members—arch limb, trough limb, and septum—are crushed together into a conformable mass, are dead. Their life of individual movement is over. If the earth pressure increases the material which they have packed together may of course form a passive part of a later fold, but they themselves can move no more.

In many cases, due partly to the action of longitudinal pressures, the septum becomes reduced to a *plane* of contrary motion, namely—the over-fault, or thrust-plane, and the arch limb and the trough limb slide past each other as two solid masses. But here we have no longer a fold, but a fault.

We see that every mountain fold commences first as a gentle alternate elevation and depression of one or more of the component sheets of the geological formations which make up the earth-crust. This movement is due apparently to the tangential thrusts set up by the creeping together, as it were, of those neighbouring and more resistant parts of the earth-crust which lie in front of and behind the moving wave. Yielding slowly to these lateral thrusts the crest of the fold rises higher and higher, the trough sinks lower and lower, the central common limb or septum grows more and more vertical and becomes more and more strained, sheared, and twisted. As this middle limb yields, the rising arch part of the fold is forced gradually over on to the sinking trough, until at last all three members come into conformable contact and further folding as such is impossible. Movement ceases, the fold is dead.

We see also from our note-book experiment that the final result of the completion of the fold is clearly to strengthen up and consolidate that part of the crust plate to the local weakness of which it actually owed its origin and position. The fold has by its life-action theoretically trebled the thickness of that part of the earth-plate in which its dead remains now lie. If the lateral pressure goes on increasing and the layers of the earth-crust again begin to fold in the same region, the inert remains of the first fold can only move as a passive part of a newer fold: either as a part of the new arch-limb, the new trough-limb, or the new septum. As each younger and younger fold formed in this way necessarily includes a more resistant, and therefore a thicker, broader, and deeper sheet of the earth-crust, we have here the phylogenetic evolution of a whole family of crust folds, each successive member of which is of a higher grade than its immediate predecessor.

But it very rarely happens that the continuous plate in which any fold is imbedded is able to resist the crust creep until the death of the first fold. Usually, long before the first simple fold is completed, a new and a parallel one rises in front of it on the side of the trough limb, and the two grow, as it were, henceforward side by side. But the younger fold, being due to a greater pressure than the older, must of necessity be of a higher specific grade, and the two together form a generic fold in common.

Our present mountain systems are all constituted of several families of folds, all formed in this way, of different gradations of size, of different dates of origin, and of different stages of life evolution; and in each family group the members are related to each other by this natural genetic affinity.

Sometimes the new folds are formed in successive order on one side of the first fold, and then we have our unilateral (or so-called unsymmetrical) mountain groups, like those of the Jura and the Bavarian Alps. Sometimes they are formed on both sides of the original fold, and then we have our bilateral (or so-called symmetrical) ranges, like the Central Alps. In both cases the septa of the aged or dead folds are of necessary all directed inwards towards the primary fold. If, therefore, they originate only on one side of the fold, our mountain group looks unsymmetrical, with a very steep side opposed to a gently sloping side. If they grow on both sides of the original fold, we have the well-known "fan structure" of mountain ranges. In this case the whole complex range is seen at a glance to be a vast compound arch of the upper layers of the earth-crust, keyed up by the material of the dead or dying folds, which by the necessities of the case constitute mighty wedges whose apices are directed inwards towards the centre of the system. But a complete arch of this kind is in reality not a single fold, but a double one, with a septum on both sides of it; and it requires two troughs, one on each side of it, as its natural complement. The so-called unsymmetrical ranges, therefore, which are constituted merely of arch limb, trough limb, and septum, are locally the more natural and the more common.

It is clear that in the lifetime of any single fold its period of greatest energy and most rapid movement must be that of middle life. In early youth the lateral pressure is applied at a very small angle, and the tangential forces act therefore under the most disadvantageous circumstances. In the middle life of the fold the arch limb and the trough limb stand at right angles to the septum, and the work of deformation is then accomplished under the most favourable mechanical conditions and with the greatest rapidity. That is to say, the activity of the fold and the rate of movement of the septum, like the speed of the storm wind, varies directly as the gradient.

In our note-book experiment we observed that little or no change took place in the arch limb and trough limb, while the septum became remarkably sheared and twisted. The same is the case in nature, but here we have to recollect that these moving mountain folds are of enormous size, indeed actual mountains in themselves. These great arches, scores of miles in length, thousands of feet in height and thickness, must of necessity be of enormous weight, capable of crushing to powder the hardest rocks over which they move, while the thrust which drives them forward is practically irresistible. It is plain, therefore, that while the great arch limb and the trough limb of one of these mighty folds move over and under each other from opposite directions, they form together an enormous machine, composed of two mighty rollers or millstones, which mangle, roll, tear, squeeze, and twist the rocky material of the middle limb or septum, which lies jammed in between them, into a laminated mass. This deformed material, which is the characteristic product of the mountain-making forces, is, of course, made up of the stuff or the original middle limb of the fold; and whether we call it breccia, mylonite, phyllite, or schist, although it may be composed of sedimentary stuff, it is certainly no longer a *stratified* rock; and though it may have been originally purely igneous material, it is certainly no longer *volcanic*. It is now a manufactured article made in the great earth mill.

These mountain folds, however, are merely the types of folds and wrinkles of all dimensions which affect the rock formations of the earth-crust. Within the mountain chains themselves we can follow them fold within fold, first down to formations, then to strata, then to laminæ, till they disappear at last in microscopic minuteness beyond the limits of ordinary vision. Leaving these, however, for the moment, let us travel rather in the opposite direction, for these mountain folds are by no means the largest known to the stratigraphical geologist. Look at any geological section crossing the continent of North America, and it will be found that the whole of the Rocky Mountain range on its western side and the Alleghany range on the east are really two mighty compound geological anticlines, while the broad sag of the Mississippi Basin is actually a compound geological syncline made up of the whole pile of the geological formations. That is to say, the continent of North America is composed of a pair of geological folds, the two arches of which are represented by the Rockies on the one side and the Alleghanies on the other, while the intermediate Mississippi syncline is the common property of both. Here, then, we reach a much higher grade of fold than the orographic or mountain-making fold, viz. the plateau-making fold or the semi-continental fold, which, because of its enormous breadth, must include a very much thicker portion of the earth-crust than the ordinary orographic fold itself.

But which must be the real middle limbs of these two American folds, those septal areas where most work is being done and the motion is greatest?

Taught by what we have already learned of the mountain wave the answer is immediate and certain. They must be on the steeper sides of each of the two folds, namely, those which face the ocean. How perfectly this agrees with the geological facts goes without saying. It is on the steep Pacific side of the western fold that the crushing and crumpling of its rocks is the greatest. It is on the Atlantic side of the eastern fold that the contortion and the metamorphism of its rocks are at their maximum, while in the common and gently sloping trough of both folds, namely, the intermediate Mississippi Valley, the entire geological sequence remains practically unmodified throughout.

Again, which of these two American folds should be the more active at the present day? Taught by our study of the mountain wave the answer again is immediate and conclusive. It must be that fold whose septum has the steeper gradient. Geology and geography flash at once into combination. The steeper Pacific septum of the western fold from Cape Horn almost to

Alaska is ablaze with volcanoes, while the gently inclined Atlantic septum of the eastern fold from Greenland to Magellan Straits shows none, except on the outer edge of the Antilles, in the very region where the slope of the surface is the steepest. We see at a glance that the vigour of these two great continental folds, like those of our mountain waves, varies directly as the surface gradient of the septum.

But the geographical surface of North America, considered as a whole, is in reality that of a double arch, with a sag or common trough in the middle. We have seen already that this double arch must be regarded as the natural complement of the equally double Atlantic trough. Here, then, if the path of analogy we have hitherto so triumphantly followed up to this point is still to guide us, the basin of the Atlantic must be, not only in appearance, but in actuality, formed of two long minor folds of the same grade as the two that form the framework of America, but with their members arranged in reverse order. If so, their submarine septa ought also to be lines of movement and of volcanic action. And this is again the case. The volcanic islands of the Azores and St. Helena lie not exactly on the longitudinal crests of the mid-oceanic *Challenger* ridge, but upon its bounding flanks.

But we have not yet, however, finished with our simple fold. If we draw a line completely round the globe, crossing the Atlantic basin at its shallowest, between Cape Verde to Cape St. Roque, and continued in the direction of Japan, where the Pacific is at its deepest, as the trace of a great circle we find that we have before us a crust fold of the very grandest order. We have one mighty continental arch stretching from Japan to Chili, broken medially by the sag of the Atlantic trough, and this great terrestrial arch stands directly opposed to its natural complement, the great trough of the Pacific, which is bent up in the middle by the mightiest of all the submarine buckles of the earth-crust, on which stand the oceanic islands of the central Pacific.

But if this be true, then the septum of all septa on our present earth-crust must cross our grandest earth fold where the very steepest gradient occurs along this line, and it must constitute the centre-point of the moving earth fold, and of greatest present volcanic activity. And where is this most sudden of all depressions? Taught once more by our geological fold, the answer is instantaneous and incontrovertible. It is on the shores of Japan, the region of the mightiest and most active of all the living and moving volcanic localities on the face of our globe.

But the course of the line which we indicated as forming our grandest terrestrial fold returns upon itself. It is an endless fold, an endless band, the common possession of two sciences. It is geological in origin, geographical in effect. It is the *wedding-ring* of geology and geography, uniting them at once and for ever in indissoluble union.

Such an endless fold, again, must have an endless septum, which, in the nature of things, must cross it twice. Need I point out to the merest tyro in these wedded sciences that if we unite the Old and New Worlds and Australia, with their intermediate sags of the Antarctic and Indian Oceans, as one imperial earth arch, and regard the unbroken watery expanse of the Pacific as its complementary depression, then the circular coastal band of contrary surface flexure between them should constitute the moving master septum of the earth crust. This is the "Volcanic girdle of the Pacific," our "Terrestrial Ring of Fire."

Or, finally, if we rather regard the compact arch of the Old World itself as the natural complement of the broken Indo-Pacific depression, then the most active and continuous septal band of the present day should divide them. Again our law asserts itself triumphantly. It is the great volcanic and earthquake band on which are strung the Festoon Islands of Western Asia, the band of Mount St. Elias, the Aleutians, Kamtchatka, the Kuriles, the band of Fusijama, Krakatoa, and Sangir. The rate of movement of the earth's surface doubtless everywhere varies directly as the gradient.

We find, therefore, that even if we restrict our observations to the most simple and elementary conception of the rock fold as being made up of arch-limb, trough-limb, and twisting but still continuous septum, we are able to connect, in one unbroken chain, the minutest wrinkle of the finest lamina of a geological formation with the grandest geographical phenomena on the face of our globe.

We find, precisely as we anticipated, that the wave-like surface of the earth of the present day reflects in its entirety the wave-like arrangement of the geological formations below. On the land we find that the surface arches and troughs answer precisely to the grander regional anticlines and synclines of the subterranean sedimentary sequence; and it may, I believe, be regarded as certain that the submarine undulations have a similar or complementary relationship. We find in the new geology, as Hutton found in the old, that geography and geology are one. We find, as we suspected, that the physiognomy of the face of our globe is an unerring index of the solid personality beneath. It bears in its lineaments the characteristic family features and the common traits of its long line of geological ancestors.

Such, it seems to me, is an imperfect account of the introductory paragraphs of that great chapter in the New Geology now in course of interpretation by geologists of the present day; and we have translated them exactly in the old way by the aid of the only living geological language, the language of present natural phenomena, and I doubt not that sooner or later the rest of this great chapter will be read by the same simple means.

I have confined myself to-day to the discussion of the characteristics of the simple geological fold as reduced to its most elementary terms of arch, trough, and unbroken septum; for this being clearly understood, the rest naturally follows. But this twisted plate is really the key which opens the entire treasure-house of the New Geology in which lie spread around in bewildering confusion facts, problems, and conclusions enough to keep the young geologist and other scientific men busily at work for many a long year to come.

Into this treasure-house I often wander myself, in the few leisure hours that I can steal from a very busy professional life; and out of it I bring now and again heresies that sometimes amuse and sometimes horrify my geological friends. As you have so patiently listened to what I have already said, perhaps you will permit me in a few final sentences to indicate in brief some of those novelties which I see already more or less clearly, and a few of those less novel points on which it appears to me that more light is wanted. My excuse is twofold—first, to furnish material for work and controversy to the young geologists; and second, to obtain aid for myself from workers in other walks of science.

The account of the simple rock-fold I have already given you is of the most elementary kind. It presupposes merely the yielding to tangential pressure from front and back, combined with effectual resistance to sliding. But in the layers of the earth-crust there is always, in addition, a set of tangential pressures theoretically at right angles to this. The simple fold becomes a *folded fold*, and the compound septum twists not only vertically but laterally. On the surface of the globe this double set of longitudinal and transverse waves is everywhere apparent. They account for the detailed disposition of our lands and our waters, for our present coastal forms, for the direction, length, and disposition of our mountain-ranges, our seas, our plains, and lakes. The compound arch becomes a dome, its complementary trough becomes a basin. The elevations and depressions, major and minor, are usually twinned, like the twins of the mineralogist, the complementary parts being often inverted, and turned through 180° (compare Italy with the Po-Adriatic depression). Every upward swirl and eddy has its answering downward swirl. The whole surface of our globe is thus broken up into fairly continuous and paired masses, divided from each other by moving areas and lines of mountain making and crust movement, so that the surface of the earth of the present day seems to stand midway in its structure and appearance between those of the sun and the moon, its eddies wanting the mobility of those of the one and the symmetry of those of the other. In the geology of the earth-crust, also, the inter-crossing of the two sets of folds, theoretically at right angles to each other, gives rise to effects equally startling. It lies at the origin of the thrust-plane or overfault, where the septal region of contrary motion in the fold becomes reduced to, or is represented by, a *plane* of contrary motion. It allows us to connect together under one set of homologies folds and faults. The downthrow side of the fault answers to the trough, the upthrow side to the arch, of our longitudinal fold; while the fault-plane itself represents the septal area reduced to zero. The node of the fault, and the alternation and alteration of throw, are due to the effects of the transverse folding.

These transverse folds of different grades, which affect different layers of the earth-crust differentially, account also for the formation of laccolites, of granitic cores, and of petrological provinces; and they enable us also to understand many of the phenomena of metamorphism.

Of the folds of the third order I shall here say nothing; but I must frankly admit that the primal cause of all this tangential movement and folding stress is still as mysterious to me as ever. I incline to think that it is due to many causes—tidal action, sedimentation, and many others. I cannot deny, however, that it may be *mainly* the result of the contraction in diameter of our earth, due to the loss of its original heat into outer space? For everywhere we find evidences of symmetrical crushing of the earth-crust by tangential stresses. Everywhere we find proofs that different layers of that crust have been affected differentially, and the outer layers have been folded the most. We seem to be dealing not so much with a solid globe as with a globular shell composed of many layers.

Is it not just possible after all that, as others have suggested, our earth is such a hollow shell, or series of concentric shells, on the surface of which gravity is at a maximum, and in whose deepest interior it is non-existent? May this not be so also in the case of the sun, through whose spot-eddies we possibly look into a hollow interior? If so, perhaps our present nebulæ may also be hollow shells formed of meteorites; on the surfaces of these shells the fiery spirals we see would be the swirls which answer to the many twisting crustal septa of the earth. Our comets, too, in this case might be elongated ellipsoids, whose visible parts would be merely interference phenomena or sheets of differential movement.

In this case we have represented before us to-day all the past of our earth as well as its present. Uniformity and evolution are one.

Thus from the microscopic septa of the laminæ of the geological formations we pass outwards *in fact* to these moving septa of our globe, marked on land by our new mountain-chains, and on our shores by our active volcanoes. Thence we sweep, *in imagination*, to the fiery eddies of the sun, and thence to the glowing swirls of the nebulæ; and so outwards and upwards to that most glorious septum of all the visible creation, the radiant ring of the Milky Way.

Prof. George Darwin, in his address to the section of mathematical and physical science at the meeting of the British Association at Birmingham in 1886, with all the courage of genius, and the authority of one of the sons of the prophets, acknowledged that it seems as likely that "meteorology and geology will pass the word of command to cosmical physics as the converse." Behind this generous admission I shelter myself. But I feel absolutely confident that long after the physicists may have swept away these provisional astronomical suggestions as "the baseless fabric of a vision," there will still remain in the treasure-house of the geological fold a wealth of abundant material for the use of the mathematician, the physicist, the chemist, the mineralogist, and the astronomer, of the deepest interest and of the highest value.

SECTION H.

ANTHROPOLOGY.

OPENING ADDRESS BY ALEXANDER MACALISTER, M.D., F.R.S., PROFESSOR OF ANATOMY IN THE UNIVERSITY OF CAMBRIDGE, PRESIDENT OF THE SECTION.

ON an irregular and unfenced patch of waste land, situated on the outskirts of a small town in which I spent part of my boyhood, there stood a notice board bearing the inscription, "A Free Coup," which, when translated into the language of the Southron, conveyed the intimation, "Rubbish may be shot here." This place, with its ragged mounds of unconsidered trifles, the refuse of the surrounding households, was the favourite playground of the children of the neighbourhood, who found a treasury of toys in the broken tiles and oyster-shells, the crockery and cabbage-stalks, which were liberally scattered around. Many a make-believe house and road, and even village, was constructed by these mimic builders out of this varied material, which their busy little feet had trodden down until its undulated surface assumed a fairly coherent consistence.

Passing by this place ten years later I found that its aspect had changed; terraces of small houses had sprung up, mushroom-like, on the unsavoury foundation of heterogeneous refuse. Still more recently I notice that these in their turn have been swept away, and now a large factory, wherein some of the most ingenious productions of human skill are constructed, occupies the site of the original waste.

This commonplace history is, in a sense, a parable in which is set forth the past, present, and possible future of that accumulation of lore in reference to humanity to which is given the name Anthropology, and for the study of which this Section of our Association is set apart. At first nothing better than a heap of heterogeneous facts and fancies, the leavings of the historian, of the adventurer, of the missionary, it has been for long, and alas is still, the favourite playground of *dilettanti* of various degrees of seriousness. But upon this foundation there is rapidly rising a more comely superstructure, fairer to see than the original chaos, but still bearing marks of transitoriness and imperfection, and I dare hazard the prediction that this is destined in the course of time to give place to the more solid fabric of a real Science of Anthropology.

We cannot yet claim that our subject is a real science in the sense in which that name is applied to those branches of knowledge, founded upon ascertained laws, which form the subjects of most of our sister Sections; but we can justify our separate existence, in that we are honestly endeavouring to lay a definite and stable foundation, upon which in time to come a scientific Anthropology may be based.

The materials with which we have to do are fully as varied as were those in my illustration, for we as anthropologists take for our motto the sentiment of Chremes, so often quoted in this Section, *humani nihil a nobis alienum putamus*, and they are too often fully as fragmentary. The bones, weapons, and pottery which form our only sources of knowledge concerning prehistoric races of men, generally come to us as much altered from their original forms as are the rusty polyhedra which once were the receptacles for biscuits or sardines. The traditions, customs, and scraps of folk-lore which are treasures to the constructive anthropologist, are usually discovered as empty shells, in form as much altered from their original conditions as are those smooth fragments of hollow white cylinders which once held the delicate products of the factory of Keiller or Cairns.

I have said that Anthropology has not yet made good its title to be ranked as an independent science. This is indicated by the difficulty of framing a definition at the same time comprehensive and distinctive. Mr. Galton characterizes it as the study of what men are in body and mind, how they came to be what they are, and whither the race is tending; General Pitt-Rivers, as the science which ascertains the true causes for all the phenomena of human life. I shall not try to improve upon these definitions, although they both are manifestly defective. On the one side our subject is a branch of biology, but we are more than biologists compiling a monograph on the natural history of our species, as M. de Quatrefages would have it. Many of the problems with which we deal are common to us and to psychologists; others are common to us and to students of history, of sociology, of philology, and of religion; and, in addition, we have to treat of a large number of other matters æsthetic, artistic, and technical, which it is difficult to range under any subordinate category.

In view of the encyclopædic range of knowledge necessary for the equipment of an accomplished anthropologist, it is little wonder that we should be, as we indeed are, little better than smatterers. Its many-sided affinities, its want of definite limitation, and the recent date of its admission to the position of an independent branch of knowledge, have hitherto caused Anthropology to fare badly in our Universities. In this respect, however, we are improving, and now in the two great English Universities there are departments for the study of the natural history of man and of his works.

Out of the great assemblage of topics which come within our sphere, I can only select a few which seem at present to demand special consideration. The annual growth of our knowledge is chiefly in matters of detail which are dull to chronicle, and the past year has not been fertile in discoveries bearing on those great questions which are of popular interest.

On the subject of the antiquity of man there are no fresh discoveries of serious importance to record. My esteemed predecessor at the Leeds meeting two years ago, after reviewing the evidence as to the earliest traces of humanity, concluded his survey with the judgment, "On the whole, therefore, it appears to me that the present verdict as to tertiary man must be in the form of 'Not Proven.'" Subsequent research has not contributed any new facts which lead us to modify that finding. The most remarkable of the recent discoveries under this head is that of the rude implements of the Kentish chalk-plateau described by Professor Prestwich; but while these are evidently of archaic types, it must be admitted that there is even yet room for difference of opinion as to their exact geological age.

Neither has the past year's record shed new light on the darkness which enshrouds the origin of man. What the future may have in store for us in the way of discovery we cannot forecast; at present we have nothing but hypothesis, and we must still wait for further knowledge with the calmness of philosophic expectancy.

I may, however, in this connection refer to the singularly interesting observations of Dr. Louis Robinson on the prehensile power of the hands of children at birth, and to the graphic pictures with which he has illustrated his paper. Dr. Robinson has drawn, from the study of the one end of life, the same conclusion which Mr. Robert Louis Stevenson deduced from the study of his grandfather, that there still survive in the human structure and habit traces of our probably arboreal ancestry.

Turning from these unsolved riddles of the past to the survey of mankind as it appears to us in the present, we are confronted in that wide range of outlook with many problems well nigh as difficult and obscure.

Mankind, whenever and however it may have originated, appears to us at present as an assemblage of tribes, each not necessarily homogeneous, as their component elements may be derived from diverse genealogical lines of descent. It is much to be regretted that there is not in our literature a more definite nomenclature for these divisions of mankind, and that such words as *race*, *people*, *nationality*, *tribe*, and *type* are often used indiscriminately as though they were synonyms.

In the great mass of knowledge with which we deal there are several collateral series of facts, the terminologies of which should be discriminated. In the first place there are those ethnic conditions existing now, or at any other point in time, whereby the individuals of mankind are grouped into categories of different comprehension, as *clans* or families, as *tribes* or groups of allied clans, and as *nations*, the inhabitants of restricted areas under one political organization. This side of our subject constitutes Ethnology.

In the second place, the individuals of mankind may be regarded as the descendants of a limited number of original parents, and consequently each person has his place on the genealogical tree of humanity. As the successive branches became in their dispersion subjected to the influences of diverse environments, they have eventually differentiated in characteristics. To each of these subdivisions of the phylum thus differentiated the name *race* may appropriately be restricted, and the sum of the peculiarities of each race may be termed *race-characters*. This is the phylogenetic side of Anthropology, and its nomenclature should be kept clearly separate from that of the ethnological side. The great and growing literature of Anthropology consists largely of the records of attempts to discover and formulate these distinctive race-characters. *Race* and *tribe* may be terms of equal extension, but the standpoint from which these categories are viewed is essentially different in the two cases.

There is yet a third series of names in common use in Descriptive Anthropology. The languages in use among men are unfortunately numerous, and as the component individuals in each community usually speak a common language, the mistake is often made of confounding the tribal name with that of the tribal language. Sometimes these categories are co-extensive; but it is not always so, for it is a matter of history that communities have been led to adopt new languages from considerations quite independent of phylogenetic or ethnic conditions. These linguistic terms should not be confounded with the names in either of the other series, for, as my learned predecessor once said in a presidential address, it is as absurd to speak of an Aryan skull as it would be to say that a family spoke a brachycephalic language.

In the one clan there may be, by intermarriage, the representatives of different races; in the one nation there may be dissimilar tribes, each derived by composite lines of ancestry from divergent phyla, yet all speaking the same language.

We have an excellent illustration of the confusion resulting from this disregard of precision in the case of the word *Celtic*, a term which has sometimes been employed as an ethnic, sometimes as a phylogenetic, and sometimes as a linguistic species. In the last-named sense, that to which I believe the use of the name should be restricted, it is the appropriate designation of a group of cognate languages spoken by peoples whose physical characters show that they are not the descendants of one common phylum in the near past. There are fair-haired, long-headed families in Scotland and Ireland; fair, broad-headed Bretons; dark-haired, round-headed Welshmen; and dark-haired, long-headed people in the outer Hebrides, McLeans, "Sancho Panza type"—men obviously of different races, who differ not only in colour, stature, and skull-form, but whose traditions also point to a composite descent, and yet all originally speaking a Celtic tongue. The use of the word *Celtic* as if it were the name of a phylogenetic species has naturally led to hopeless confusion in the attempts to formulate race-characters for the Celtic skull—confusions of a kind which tend to bring physical anthropology into discredit. Thus Retzius characterizes the Celtic crania as being dolichocephalic, and compares them with those of the modern Scandinavians. Sir Daniel Wilson considers the true Celtic type of skull as intermediate between the dolichocephalic and the brachycephali; and Topinard figures as the typical Celtic skull that of an Auvergnat, extremely brachycephalic, with an index of 85!

Our traditional history tells that we, the Celtic-speaking races of Britain, are not of one common ancestry, but are the descendants of two distinct series of immigrants, a British and a Gaelic. Whatever may have been the origin of the former, we know that the latter are not homogeneous, but are the mixed descendants of the several Fomorian, Nemedian, Firbolg, Tuatha de Danaan, and Milesian immigrations, with which has been combined in later times a strong admixture of Scandinavian blood. It is now scarcely possible to ascertain to which of these component strains in our ancestry we owe the Celtic tongue which overmastered and supplanted the languages of the other tribes, but it is strictly in accordance with what we know of the history of mankind that this change should have taken place. We have instances in modern times of the adoption by conquered tribes of the language of a dominant invading people. For example, Mr. Hale has lately told us that the speech of the Hupas has superseded the languages of those Californian Indians whom they have subdued. In like manner, nearer home, the English language is slowly but surely supplanting the Celtic tongues themselves.

We may here parenthetically note that what has been observed in the case of language has also taken place in reference to ritual and custom. Observances which have a history and a meaning for one race have, in not a few instances, been adopted by or imposed upon other races to whom they have no such significance, and who in incorporating them give to them a new local colour. These pseudomorphs of the earlier cultures are among the most perplexing of the problems which the student of comparative religion or folk-lore has to resolve.

But we want more than a perfect nomenclature to bring Anthropology into range with the true sciences. We need a broader basis of ascertained fact for inductive reasoning in almost all parts of our subject; we want men trained in exact method who will work patiently at the accumulation, verification, and sorting of facts, and who will not prematurely rush into theory. We have had enough of the untrained writer of papers, the jerry-builder of unfounded hypotheses whose ruins cumber our field of work.

The present position of our subject is critical and peculiar; while on the one hand the facilities for anthropological research are daily growing greater, yet in some directions the material is diminishing in quantity and accessibility. We are accumulating in our museums treasures both of the structure and the works of man, classified according to his distribution in time and space; but at the same time some of the most interesting tribes have vanished, and others are rapidly disappearing or becoming fused with their neighbours. As these pass out of existence we, with them, have lost their thoughts, their tongues, and their traditions; for even when they survive, blended with other races, that which was a religion has become a fragmentary superstition, then a nursery tale, or a child's game, and is destined finally to be buried in oblivion. The unifying influences of commerce, aided by steam and electricity, are effectually effacing the landmarks between people and people, so that if we are to preserve in a form fit for future use the shreds which remain of the myths, folk-lore, and linguistic usages of many of the tribes of humanity, we must be up and doing without delay. It is on this account that systematic research such as that which Mr. Risley has advocated with regard to the different races of India is of such pressing and urgent importance. It is for this reason likewise that we hail with pleasure the gathering of folk-lore while yet it survives, and welcome such societies for the purpose as the Folk-lore Congress recently inaugurated.

I have said that in the department of Physical Anthropology our facilities for research are increasing. The newly-founded anthropometric laboratories are beginning to bring forth results in the form of carefully compiled statistical tables, embodying the fruits of accurate observations, which are useful as far as they go. Were these extended in their scope the same machinery might easily gather particulars as to the physical characters of the inhabitants of different districts, which would enable the anthropologist to complete in a systematic manner the work which Dr. Beddoe had so well begun. I would commend this work to the consideration of the provincial university colleges, especially those in outlying districts.

Of all the parts of the human frame, the skull is that upon which anthropologists have in the past expended the most of their time and thought. We have now, in Great Britain alone, at least four collections of skulls, each of which includes more than a thousand specimens, and in the other great national and university museums of Europe there are large collections available for study and comparison.

Despite all the labour that has been bestowed on the subject, craniometric literature is at present as unsatisfactory as it is dull. Hitherto observations have been concentrated on cranial measurements as methods for the discrimination of the skulls of different races. Scores of lines, arcs, chords, and indexes have been devised for this purpose, and the diagnosis of skulls has been attempted by a process as mechanical as that whereby we identify certain issues of postage-stamps by counting the nicks in the margin. But there is underlying all these no unifying hypothesis, so that when we, in our sesquipedalian jargon describe an Australian skull as microcephalic, phænozygous, tapeino-dolichocephalic, prognathic, platyrhine, hypselopalatine, leptostaphyline, dolichuranic, chamæprosopic, and microseme, we are no nearer to the formulation of any philosophic concept of the general principles which have led to the assumption of these characters by the cranium in question, and we are forced to echo the apostrophe of Von Török, "Vanity, thy name is Craniology."

It was perhaps needful in the early days of the subject that it should pass through the merely descriptive stage; but the time has come when we should seek for something better, when we should regard the skull not as a whole complete in itself, nor as a crystalline geometrical solid, nor as an invariable structure, but as a marvellously plastic part of the human frame, whose form depends on the co-operation of influences, the respective shares of which in moulding the head are capable of qualitative if not of quanitative analysis. Could measurements be devised which would indicate the nature and amounts of these several influences, then, indeed, would craniometry pass from its present empirical condition, and become a genuine scientific method. We are yet far from the prospect of such an ideal system, and all practical men will realize the immense, but not insuperable, difficulties in the way of its formulation.

In illustration of the profound complexity of the problem which the craniologist has to face, I would ask your indulgence while I set out a few details to show the several factors whose influence should be numerically indicated by such a mode of measurement.

The parts composing the skull may be resolved into four sets: there is, first, the brain-case; secondly, the parts which subserve mastication and the preparation of the food for digestion; thirdly, the cavities containing the organs of the senses of hearing, sight, and smell; and fourthly, those connected with the production of articulate speech. If our measurements are to mean anything, they should give us a series of definite numbers indicating the forms, modifications, and relative size of these parts, and their settings with regard to each other and to the rest of the body.

To take the last point first, it needs but a small consideration to show that the parts of the skull are arranged above and below a certain horizontal plane, which is definite (although not easily ascertained) in every skull, human or animal. This is the plane of vision. The familiar lines of Ovid—

> Pronaque cum spectent animalia cetera terram,
> Os homini sublime dedit; cœlumque tueri
> Jussit, et erectos ad sidera tollere vultus—

are anatomically untrue, for the normal quadruped and man alike, in their most natural position, have their axis of vision directed to the horizon. Systems of measurement based upon any plane other than this are essentially artificial. There are at the outset difficulties in marking the plane accurately on the skull, and it is to be deplored that the anthropologists of different nations should have allowed themselves to be affected by extraneous influences, which have hindered their unanimous agreement upon some one definite horizontal plane in craniometry.

The Frankfort plane drawn through the upper margins of the auditory foramina and the lowest points of the orbital borders has the advantage of being easily traced and differs so little from the plane of vision that we may without substantial error adopt it.

The largest part of the skull is that which is at once the receptacle and the protector of the brain, a part which, when unmodified by external pressure, premature synostosis, or other adventitious conditions, owes its form to that of the cerebral hemispheres which it contains. Speaking in this city of George and Andrew Combe, I need not do more than indicate in this matter that observation and experiment have established on a firm basis certain fundamental points regarding the growth of the brain. The study of its development shows that the convolutioning of the cerebral hemisphere is primarily due to the connection, and different rate of growth, of the superficial layer of cells with the underlying layers of white nerve fibres; and that so far from the shape being seriously modified by the constraining influence of the surrounding embryonic skull, the form of the soft membranous brain-case is primarily moulded upon the brain within it, whose shape it may however be, to some extent, a secondary agent in modifying in later growth. We have also learned that, although in another sense from that of the crude phrenology of Aristotle, Porta, or Gall, the cerebrum is not a single organ acting as a functional unit, but consists of parts, each of which has its specific province; that the increase in the number of cells in any area is correlated with an increase in the size and complexity of pattern of the convolutions of that area; and that this in turn influences the shape of the enclosing shell of membrane and subsequently of bone.

The anatomist and the physiologist have worked hand in hand in the delimitation of these several functional areas, and pathology and surgery have confirmed what experimental physiology has taught. The topography of each part of the cerebrum, so important to the operating surgeon, should be pressed into the service of the anthropologist, whose measurements of the brain-case should have definite relation to these several areas. In the discussion which is to take place on this subject, I hope that some such relationships will be taken account of. This is not the place to work out in detail how this may be done; I only desire to emphasize the fundamental principle of the method.

The second factor which determines the shape of the individual skull is the size of the teeth. That these differ among different races is a matter of common observation; thus the average area of the crowns of the upper-jaw teeth in the male Australian is 1,536 sq. mm., while in the average Englishman it is only 1,286 sq. mm., less than 84 per cent. of that size.[1]

It is easy to understand how natural selection will tend to increase the size of the teeth among those races whose modes of feeding are not aided by the cook or the cutler; and how, on the other hand, the progress of civilised habits, assisted by the craft of the dentist, interferes with the action of selection in this matter among the more cultured races.

For larger teeth a more extensive alveolar arch of implantation is necessary; and as the two jaws are commensurately developed, the lower jaw of the macrodontal races exceeds that of the meso- or microdontal races in weight. Thus that of a male Australian exceeds that of the average Englishman in the proportion of 100 : 91.

To work this heavier jaw more powerful muscles are needed.

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[1] These and the succeeding averages are from my own measurements, taken from never less than ten individual cases.

In the average well-developed Englishman with perfect teeth the weight of the fleshy portion of the great jaw-muscles, masseters and temporals, is 60 grammes, while the weight of those as ascertained in two Australians was 74 grammes.

Correlated with this greater musculature a sharper definition of the areas for the attachments of the jaw-muscles is required. The muscular fascicles are approximately of uniform size in both microdonts and macrodonts, as the range of motion of the jaw differs little in different races; but when the skull is smaller on account of the smaller size of the brain which it contains, the temporal crest ascends higher on the side-wall. In the average Englishman the temporal crests at their points of greatest approximation anteriorly across the brows are 112 mm. apart, but in the Australian they are only separated by 103 mm.: the interstephanic distances in these two are respectively 132 and 114 mm.

The more powerful stroke of the mandibular teeth upon the anvil of the upper-jaw teeth in macrodonts renders necessarily a proportionally stronger construction of the bases of support for the upper alveolar arch. In any skull this arch requires to be solidly connected to the wall of the brain-case to which the shock of the impact is ultimately transmitted, and in order to protect from pressure the delicate intervening organs of sight and smell, the connection is accomplished by the reversed arches of the infraorbital margins with their piers, malar and maxillary, founded on the frontal angular processes. These foundations are tied together by the strong supraorbital ridge, so that the whole orbital edge is a ring, made up of the hardest and toughest bone in the skeleton.

A twofold modification of this arrangement is required in the macrodont skull. The bony circum-orbital ring becomes stronger, especially along its lateral piers; and also as the alveolar arch is longer, and consequently projects farther forward, its basis of support must be extended to meet and bear the malar and maxillary piers. But macrodonts are often microcephalic, and therefore the frontal region of the skull must be adjusted to form a foundation for this arch. In the average English male skull, held with its visual axes horizontal, a perpendicular dropped from the anterior-surface of the fronto-nasal suture will cut the plane of the alveolar arch between the premolar teeth or through the first premolar. In an Australian skull the perpendicular cuts the horizontal plane at the anterior border of the first molar teeth.

It is obvious, therefore, that to ensure firmness, the piers of the arches must be obliquely set; hence the jaw is prognathous, but it is also needful that the supra-orbital arcade should be advanced to meet and bear these piers, as the mandibular stroke is always vertical.

But the inner layer of the skull is moulded on the small frontal lobes of the brain, so this forward extension must affect only the much thicker and tougher outer table of the skull, which, at the period of the second dentition, here separates from the inner table, the interval becoming lined by an extension of the mucosa of the anterior ethmoidal cell. In this way an air space, the frontal sinus, is formed, whose development is thus directly correlated to the two factors of brain development and size of the teeth. If the frontal lobes are narrow in a macrodont skull, then the foundations of the outer or malar piers of the orbital arch must be extended outwards as well as forwards, the external angular process becoming a prominent abutment at the end of a strong low-browed supraorbital arch, whose overhanging edge gives to the orbital aperture a diminished vertical height.

The crania of the two most macrodont races of mankind, Australian and African, differ in the relation of the jaw to the frontal bone. In the microcephalic Australian, the maxillæ are founded upon the under side of the shelf-like projection of the outer table of the frontal, which juts out as a buttress to bear it. On the other hand the nasal processes of the mesocephalic negro ascend with greater obliquity to abut on the frontal, and have, by their convergence, crushed the nasal bones together, and caused their coalescence and diminution.

The crania of the two most microcephalic races present distinctive features of contrast along the same lines. The Bushman's skull is usually orthognathous, with a straight forehead and a shallow frontonasal recess, while the Australian skull is prognathous with heavy overhanging brows. These conditions are correlated to the mesodontism of the Bushman and the macrodontism of the Australian respectively.

In the course of the examination of the relations of brain development to skull growth, some interesting collateral points are elicited. The frontal bone grows from lateral symmetrical centres, which medially coalesce, union taking place usually between the second and sixth years of age. It has been noticed by anthropologists that metopism, as the anomalous non-union of the halves of this bone has been termed, is rare among microcephalic races, occurring only in about 1 per cent. among Australian skulls. Increased growth of the frontal lobes as the physical accompaniment of increased intellectual activity interposes an obstacle to the easy closure of this median suture, and so in such races as the ancient Egyptian, with a broader forehead, metopism becomes commoner, rising to 7 per cent. In modern civilised races the percentage ranges from 5 to 10. In following out the details of this enumeration, I have spoken as if the microdontal condition had been the primary one, whereas all the available evidence leads to show that the contrary was the case. The characters of all the early crania, Neanderthal Engis, and Cromagnon, are those of macrodonts. The progress has been from the macrodont to the microdont, as it probably was from the microcephalic to the macrocephalic.

The effects of the variations in size of the teeth are numerous and far-reaching. The fluctuation in the weight of the jaw depending on these variations has an important influence on the centre of gravity of the head, and affects the set of the skull on the vertebral column. This leads to a consequent change in the axes of the occipital condyles, and it is one of the factors which determines the size of the neck-muscles, and therefore the degree of prominence of the nuchal crests and mastoid process.

As the teeth and alveolar arches constitute a part of the apparatus for articulate speech, so these varieties in dental development are not without considerable influence on the nature of the sound produced. The necessarily larger alveolar arch of the macrodont is hypseloid or elliptical, more especially when it has to be supported on a narrow frontal region, and this is associated with a more extensive and flatter palatine surface. This, in turn, alters the shape of the mouth cavity, and is associated with a wide flat tongue, whose shape participates in the change of form of the cavity of which it is the floor. The musculature of the tongue varies with its shape and its motions, upon which articular speech depends, become correspondingly modified. For example, the production of the sharp sibilant S requires the approximation of the raised flexible edge of the tongue to the inner margins of the teeth behind the canines, and to the palatine margin close behind the roots of the canine and lateral incisor teeth. This closes the vocal tube laterally, and leaves a small lacuna about 5 mm. wide anterially, through which the vibrating current of air is forced. A narrow strip of the palate behind the medial halves of the median incisors bounds this lacuna above, and the slightly concave raised tongue-tip limits it below.

With the macrodont alveolar arch, and the correspondingly modified tongue, sibilation is a difficult feat to accomplish, and hence the sibilant sounds are practically unknown in all the Australian dialects.

It is worthy of note that the five sets of muscular fibres, whose function it is to close laterally the flask-like air-space between the tongue and the palate, are much less distinct and smaller in the tongues of the Australians which I have examined than in the tongues of ordinary Europeans.

There is a wide field open to the anatomical anthropologist in this investigation of the physical basis of dialect. It is one which requires minute and careful work, but it will repay any student who can obtain the material, and who takes time and opportunity to follow it out. The anatomical side of phonology is yet an imperfectly known subject, if one may judge by the crudeness of the descriptions of the mechanism of the several sounds to be found even in the most recent text-books. As a preliminary step in this direction we are in urgent need of an appropriate nomenclature and an accurate description of the muscular fibres of the tongue. The importance of such a work can be estimated when we remember that there is not one of the 260 possible consonantal sounds known to the phonologist which is not capable of expression in terms of lingual, labial, and palatine musculature.

The acquisition of articulate speech became possible to man only when his alveolar arch and palatine area became shortened and widened, and when his tongue, by its accommodation to the modified mouth, became shorter and more horizontally flattened, and the higher refinements of pronunciation depend for their production upon more extensive modifications in the same directions.

I can only allude now very briefly to the effects of the third set of factors, the sizes of the sense organs, on the conformation of the skull. We have already noted that the shape and the size of the orbital opening depend on the jaw as much as on the eye. A careful set of measurements has convinced me that the relative or absolute capacity of the orbital cavity is of very little significance as a characteristic of race. The microseme Australian orbit and the megaseme Kanaka are practically of the same capacity, and the eyeballs of the two Australians that I have had the opportunity of examining are a little larger than those of the average of mesoseme Englishmen.

The nasal fossæ are more variable in size than the orbits, but the superficial area of their lining and their capacity are harder to measure, and bear no constant proportion to the size of their apertures, because it is impossible without destroying the skull to shut off the large air sinuses from the nasal fossæ proper for purposes of measurement. Thus the most leptorhine of races, the Esquimaux, with an average nasal index of 437 has a nasal capacity of 55 c.c.m., equal to that of the platyrhine Australian, whose average is 54·5, and both exceed the capacity of the leptorhine English, which average about 50 c.c.m. There is an intimate and easily proved connection between dental size and the extent of the nasal floor and of the pyriform aperture.

These are but a few of the points which a scientific craniometry should take into consideration. There are many others to which I cannot now refer, but which will naturally occur to the thoughtful anatomist.

In this rapid review of the physical side of our subject the study of these race-characters naturally suggests the vexed question as to the hereditary transmission of acquired peculiarities. This is too large a controversy for us now to engage in, but in the special instances before us there are grounds for the presmption that these characters of microdontism and megacephaly have been acquired at some stage in the ancestral history of humanity, and that they are respectively correlated, with diminution of use in the one case, and increase of activity in the other. It is a matter of observation that these qualities have become hereditary, and the point at issue is not the fact, but the mechanism, of the transmission. We know that use or disuse affects the development of structure in the individual, and it is hard to believe that the persistent disuse of a part through successive generations does not exercise a cumulative influence on its ultimate condition.

There is a statement in reference to one of these characters which has gained an entrance into the text-books, to the effect that the human alveolar arch is shortening, and that the last molar tooth is being crowded out of existence. I have examined 400 crania of men of the long, and round-barrow races, Romano-British and early Saxon, and have not found among all these a single instance of absence of the third molar or of overcrowded teeth. On the other hand, out of 200 ancient Egyptian skulls, 9 per cent. showed displacement or disease, and 1½ per cent. show the want of one molar tooth. Out of 200 modern English skulls there was no third molar tooth in 1 per cent. So far this seems to confirm the current opinion.

Yet the whole history of the organism bears testimony to the marvellous persistence of parts in spite of contumely and disuse. Take, for example, the present position of the little toe in man. We know not the condition of this digit in prehistoric man, and have but little information as to its state among savage tribes at the present day, but we do know that in civilised peoples, whose feet are from infancy subjected to conditions of restraint, it is an imperfect organ—

> Of every function shorn
> Except to act as basis for a corn.

In 1 per cent. of adults the second and third joints have ankylosed, in 3 per cent. the joint between them is rudimentary, with scarcely a trace of a cavity, in 20 per cent. of feet the organ has lost one or more of its normal complement of muscles. But though shorn of some of its elements, and with others as mere shreds, the toe persists, and he would be a bold prophet who would venture to forecast how many generations of booted ancestry would suffice to eliminate it from the organization of the normal man.

Nevertheless, although it is difficult to demonstrate, in the present imperfect state of knowledge, the method whereby race-characters have originated, I think that the most of our anthropologists at least covertly adopt the philosophy of the ancient proverb, "The fathers have eaten sour grapes and the children's teeth are set on edge."

But there are other branches of anthropology of far greater interest than these simple problems upon which we have tarried so long. The study of man's intellectual nature is equally a part of our subject, and the outcomes of that nature are to be traced in the tripartite record of human progress which we call the history of culture. It is ours to trace the progress of man's inventions, and their fruits in language and the arts, the direct products of the human mind. It is also ours to follow the history of man's discovery of those secrets of nature to the unfolding of which we give the name of science. The task is also ours to inquire into that largest and most important of all sections of the history of culture which deals with the relation of human life to the unseen world, and to disentangle out of the complex network of religion, mythology, and ritual those elements which are real truths, either discovered by the exercise of man's reason, or learned by him in ways whereof science takes no account, from those adventitious and invented products of human fear and fancy which obscure the view of the central realities. In this country it matters less that our time forbids us to wander in these fascinating fields wherein the anthropologist loves to linger, as the munificent benefaction of Lord Gifford has ensured that there shall he an annual fourfold presentation of the subject before the students of our Scottish universities. There is no fear that interest in these questions will flag for want of diversity in the method of treatment or of varieties in the standpoints of the successive Gifford lecturers.

From the ground of our present knowledge we can but faintly forecast the future of Anthropology, when its range is extended by further research, and when it is purged of fancies, false analogies, and imperfect observations. It may be that there is in store for us a clearer view of the past history of man, of the place and time of his first appearance, of his primitive character, and of his progress. But has this knowledge, interesting as it may be for its own sake, any bearing on the future of mankind? Hitherto growth in knowledge has not been accompanied with a commensurate increase in the sum of human happiness, but this is probably due to the imperfection which characterises even our most advanced attainments. For example, while the medical and sanitary sciences, by their progress, are diminishing the dangers which beset humanity, they have also been the means of preserving and permitting the perpetuation of the weaklings of the race, which, had natural selection exercised its unhindered sway, would have been crushed out of existence in the struggle for life.

It is, however, of the essence of true scientific knowledge, when perfected, that it enables us to predict, and if we ever rise to the possession of a true appreciation of the influences which have affected mankind in the past, we should endeavour to learn how to direct these influences in the future that they shall work for the progress of the race. With such a knowledge we shall be able to advance in that practical branch of Anthropology, the science of education; and so to guide and foster the physical, intellectual, and moral growth of the individual that he will be enabled to exercise all his powers in the best possible directions. And lastly, we shall make progress in that kindred department, Sociology, the study of which does for the community what the science of education does for the individual. Is it a dream that the future has in store for us such an Anthropological Utopia?

PHYSICS AT THE BRITISH ASSOCIATION.

THE mathematicians and physicists of the British Association could not have had better accommodation than that which was placed at their disposal in Edinburgh. The physics lecture-room of a University, with its appropriate fittings and appliances, is their ideal environment. Almost all the leading British physicists were present, the chief absentee of note being Lord Rayleigh, and foreign men of science were well represented by such men as Profs. von Helmholz, Wiedemann, Ostwald, and Du Bois, from Germany; M. Guillaume, from France; Schoute, from Holland; and Michelson, from America.

The *Discussion on a National Physical Laboratory* was one of the most important.

The speakers were Oliver Lodge, Glazebrook, von Helmholz, Lord Kelvin, Rücker, Dr. John Ince, Fitzgerald, Stokes, Carey Foster, Ayrton, and the President.